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Agricultural Memorandum No 881

Map of growing season in Scotland based on mean daily air temperature 6°C or greater

Introduction

The Agricultural Unit based at the Meteorological Office in Edinburgh was asked by the Countryside Commission of Scotland to prepare a map of the growing season in Scotland to fit their requirements.

The requirements set out by the Countryside Commission were:-

1. The final map should be suitable for reproduction at A4 size.

2. The map should show up to 5 zones each with a different length of growing season.

3. The zones would be keyed on the map to give the approximate time and month of each season e.g. 1st week in April - 2nd week in November.

4. The zones would be prepared in as simple a manner as possible using the average daily mean temperature for 1941-1970 with 6°C being taken as the minimum temperature required. These values would not be reduced to mean sea level.

It was accepted that the extrapolation of this data into topographical zones would be one of educated subjectivity and would take into account the fact that their interest is only in land below the tree line. There was also a limit to the amount of money the Countryside Commission were able to pay for this service. The actual zones used in the final map were agreed after discussion with a member of the Countryside Commission.

This paper gives details of the preparation of the map.

Available data

Since 1941-70 averages of daily mean temperature were readily available for both long term and short term stations in Scotland it was decided to try and fit suitable regression equations to this data which would give estimates of the length of growing season and of the dates for the start and finish of the growing season.

Daily averages and monthly averages of daily mean air temperature were obtained for 22 stations in Scotland and the extreme north of England (listed in Table I) over the period 1959-1977. The stations were selected to give as wide a range as possible both geographically and in length of growing season. The choice of data was limited to that which was easily available on computer.

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Derived formulae

Using the 1959-1977 daily averages of daily mean temperature the length and dates of the start and finish of the growing season were extracted for the 22 stations. The start of the growing season was taken as the date on which the daily mean temperature reached 6°C or greater and remained above 6°C. The end of the growing season was taken as the last day on which the daily mean temperature remained at 6°C or greater. From these two dates the length of the growing season was calculated. All but one of these stations gave starting dates in April and finishing dates in November and thus it was decided to obtain a set of regression equations using the average monthly mean temperatures for April and November.

The following equations and correlation coefficients were obtained:-

(1) Start of growing season = $153.35 - 7.7\ T_A$ $r = 0.88$

(2) End of growing season = $288.29 + 4.5\ T_N$ $r = 0.95$

(3) Length of growing season = $139.69 + 5.7\ T_A + 6.5\ T_N$ F test $p < .001$

where T_A = April mean temperature

T_N = November mean temperature

r = correlation coefficient.

The daily mean temperature averages for 1959-1977 for April and November for the 22 stations were inserted in the equations and the observed and calculated values were noted in Table I.

A 't' test was used to find the significance of the derived values compared to the observed values and there was no significant difference at the 1% level.

Working map

The 1941-1970 averages of daily mean temperature for April and November for sites in Scotland and the extreme north of England (Table II) were inserted in equations (1) to (3) to enable three maps to be plotted showing: Map 1 - start of growing season, Map 2 - end of growing season, Map 3 - length of growing season. By overlaying this map on each of the other two in turn the range of the dates of start and finish of the growing season within each 10 day range of length of growing season was found.

Variation with height above msl

The map was completed using the derived values without any reduction to mean sea level and the general topography was considered when drawing the isopleths of length of growing season. To give some indication of how the length of growing season varies with height stations in the north east area were considered and the growing season was found to decrease by 8 days for each 100 m increase in height above mean sea level.

The variation in length of growing season with height has since been calculated for other areas and in each case the variation was found to be 8 days/100 metres.

Variation about the average length of growing season

To give some indication of how the length of growing season could vary about the average value one station was studied in detail. Royal Botanic Garden, Edinburgh was selected for this study as there was a complete record for the period 1941-1970.

The criteria for the start and finish of the growing season were altered to calculate the growing season for each individual year. One or two days with a mean air temperature below 6°C were not considered to give rise to a break in the growing season but a period of three days or more at the start of the growing season was taken to mean that the growing season had not yet started. Similarly at the end of the growing season the first occurrence of a run of three days each with a mean air temperature below 6°C was taken to signify that the growing season had ended.

Using the dates of start and finish of the growing season the length of growing season was obtained for each year. The average value and those equivalent to a 1 year in 10 frequency are given in Table III.

Conclusions

This work has produced a map of growing season to a particular specification. Work is currently being undertaken to produce maps of growing season related to 30 cm soil temperatures. This is to provide continuity with other work being done in the United Kingdom.

Any comments or suggestions about this paper should be referred to the author.

J P Love
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TABLE I

Station	Observed			Calculated		
	Start of growing season (Day No)	End of growing season (Day No)	Length of growing season (Days)	Start of growing season (Day No)	End of growing season (Day No)	Length of growing season (Days)
Kirkwall	105	312	208	106	313	210
Wick	104	312	209	106	312	209
Benbecula	94	318	225	98	317	222
Nairn	99	312	214	101	311	211
Balmoral	123	303	181	114	301	187
Craibstone	104	311	208	105	310	207
Turnhouse	99	312	214	97	311	214
Blackford Hill	99	313	215	98	313	216
R.B.G.	99	313	215	96	313	217
Penicuik	104	306	203	104	308	204
Bush House	104	306	203	105	309	205
Haddington	99	313	215	97	312	215
Dunbar	99	317	219	97	316	222
Tiree	93	319	227	96	320	228
Glasgow A/P	95	312	218	95	312	217
Auchincruive	95	316	222	96	314	219
Bowhill	104	306	203	102	308	205
West Linton	105	306	202	108	305	197
Marchmont	104	306	203	103	309	207
Eskdalemuir	105	306	202	108	306	198
Dumfries	99	313	215	97	313	216
Kielder Castle	105	306	202	109	305	197

TABLE II AVERAGE GROWING SEASON DATES FOR 1941-1970 USED IN PREPARATION OF WORKING MAP

		Start	End	Length			Start	End	Length
1	Strathy	103	312	211	51	Barrhead	96	315	221
2	Dounreay	102	315	216	52	Falkirk	93	313	221
3	Wick	104	315	215	53	Blackford Hill	96	315	221
4	Lairg	102	307	203	54	Royal Botanic Garden	94	314	221
5	Fortrose	97	316	222	55	Dunbar	96	318	225
6	Inverness	94	313	220	56	Penicuik	102	310	209
7	Nairn	98	313	217	57	St Abb's Head	100	318	223
8	Forres	98	312	215	58	Turnhouse	97	314	219
9	Kinloss	98	314	218	59	Haddington	97	314	219
10	Lossiemouth	100	312	214	60	North Berwick	96	316	222
11	Elgin	96	315	221	61	Balerno	104	310	207
12	Gordon Castle	97	314	219	62	Boghall/Bush House	103	311	209
13	Banff	97	317	223	63	Mid Calder	100	312	213
14	Tarbatness	99	315	219	64	East Craigs	96	313	219
15	Glenmore Lodge	112	304	193	65	Davidsons Mains	95	313	219
16	Huntly	103	309	208	66	Liberton	94	315	222
17	Clashnoir Cottage	114	303	190	67	West Linton	107	307	201
18	Achnagoichan	107	305	198	68	Blyth Bridge	107	308	203
19	Fyvie Castle	102	309	207	69	Bowhill	100	310	210
20	Craibstone	103	312	211	70	Stanhope Farm	105	309	205
21	Dyce	102	312	212	71	Sourhope Farm	107	309	205
22	Aberdeen	101	312	213	72	Lauder	103	308	205
23	Braemar	113	304	191	73	Wauchope	103	309	207
24	Balmoral	111	303	192	74	Glentress	102	310	210
25	Glensaugh	106	309	206	75	Whitchester	107	308	203
26	Pitlochry	100	310	210	76	Marchmont	100	311	213
27	Blairgowrie	98	310	213	77	Floors Castle	97	311	214
28	Stonehaven	101	314	216	78	Berwick-on-Tweed	97	316	222
29	Faskally	99	310	211	79	Auchincruive	94	316	223
30	Glamis Castle	101	309	208	80	Kilmarnock	94	315	222
31	Muchalls	103	313	213	81	Turnberry	93	319	230
32	Perth	94	312	217	82	Colmonell	97	317	223
33	Arbroath	100	315	217	83	Tongland	96	315	221
34	Carnoustie	98	314	218	84	Mull of Galloway	96	323	233
35	Mylnefield	98	312	215	85	Penwhirn	105	314	213
36	Dundee	96	313	218	86	West Freugh	97	318	225
37	Montrose	101	312	213	87	Dumfries	96	314	220
38	Leuchars	96	315	221	88	Ruthwell	95	313	218
39	St Andrews	97	314	219	89	Moniaive	103	311	209
40	Kirkcaldy	96	313	218	90	Achnashellach	100	312	213
41	Dunfermline	95	313	219	91	Duntulm	100	318	223
42	Cupar	96	313	218	92	Onich	97	316	221
43	Pitreavie	94	315	222	93	Greenock	93	318	227
44	Carluke	98	314	218	94	Tiree	94	322	233
45	Springburn Park	96	312	217	95	Eskdalemuir	107	309	204
46	Paisley	90	317	228	96	Glenlee	97	313	217
47	Renfrew/Abbotsinch	93	315	224	97	Kirkwall	105	316	216
48	Stirling	91	314	223	98	Benbecula	96	320	228
49	Carnwath	107	307	201	99	Stornoway	100	317	221
50	Coatbridge	96	313	218	100	Cape Wrath	105	318	219

		Start	End	Length			Start	End	Length
101	Fort Augustus	99	312	215	114	Dundeugh	103	310	209
102	Helensburgh	97	313	218	115	Thorntonhall	101	311	211
103	Kielder Castle	110	308	200	116	Dalwhinnie	115	303	189
104	Fort William	96	315	221	117	Glentochar	97	314	219
105	Rhum	95	319	228	118	Castle Douglas	100	312	213
106	Kinlochewe	97	314	219	119	Threave	98	313	217
107	Prabost	99	316	220	120	Glenshee Lodge	112	303	192
108	Ardtalnaig	99	312	215	121	Strathyre	104	309	206
109	Barr	100	313	215	122	Largs	90	319	231
110	Bargrennan	100	314	217	123	Lerwick	112	313	207
111	Glenbranter	98	313	216	124	Baltasound	108	313	210
112	Leadhills	111	305	195	125	Benmore	94	315	222
113	Rhuvaal	93	324	235	126	Achaglachgach	96	316	222

1 April	=	91
15 April	=	105
30 April	=	120
1 November	=	305
15 November	=	319
30 November	=	334

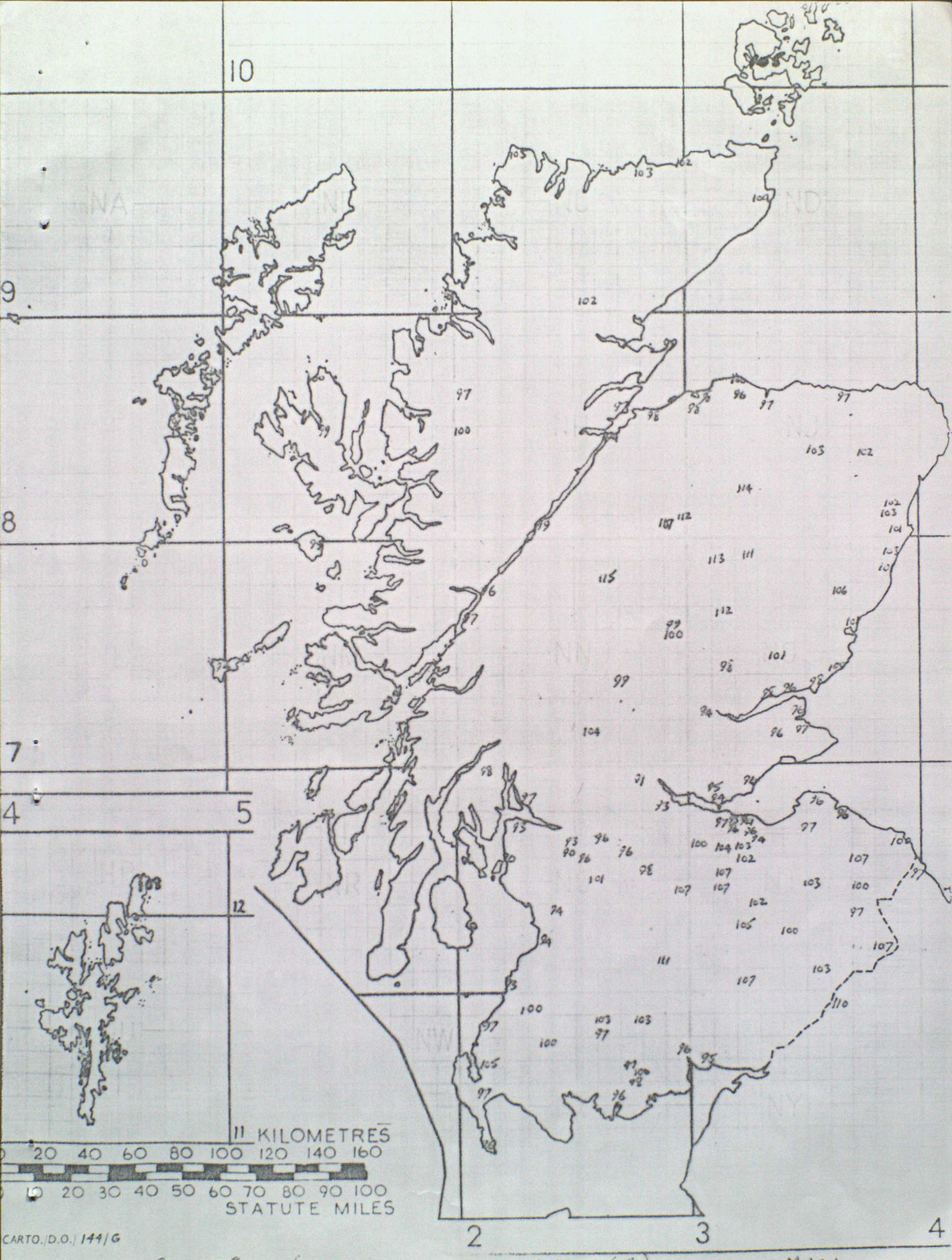
TABLE III VARIATIONS IN GROWING SEASON AT ROYAL BOTANIC GARDEN, EDINBURGH, 1941-1970

(a)

	Start of growing season	End of growing season
1 year in 10 early	7 March	27 October
1 year in 10 late	21 April	30 November
Average	1 April	9 November

(b)

	Length of growing season (days)
1 year in 10 short	197
1 year in 10 long	254
Average	222



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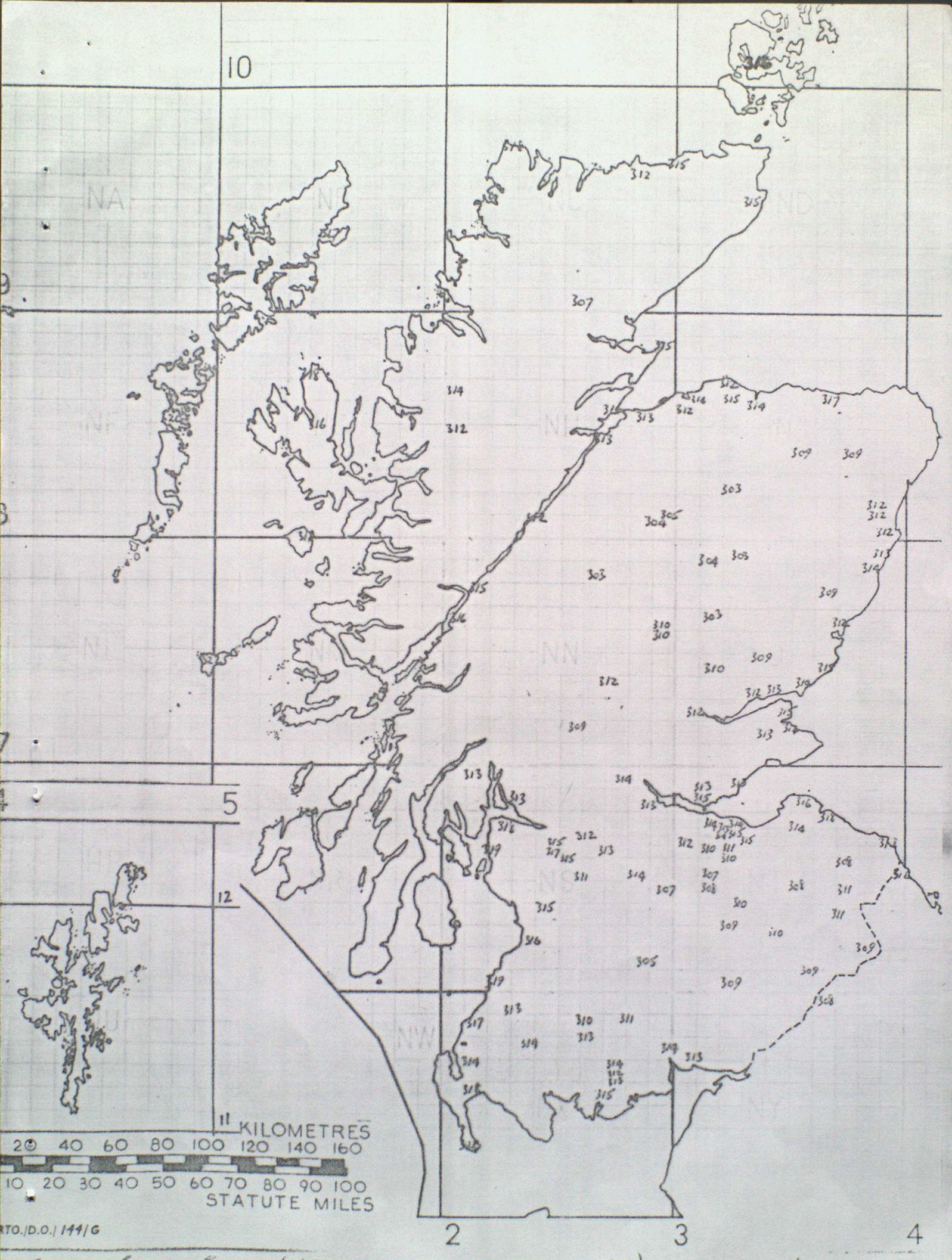
START OF GROWING SEASON (BASED ON MEAN AIR TEMP. ABOVE 6°C).

MAP 1



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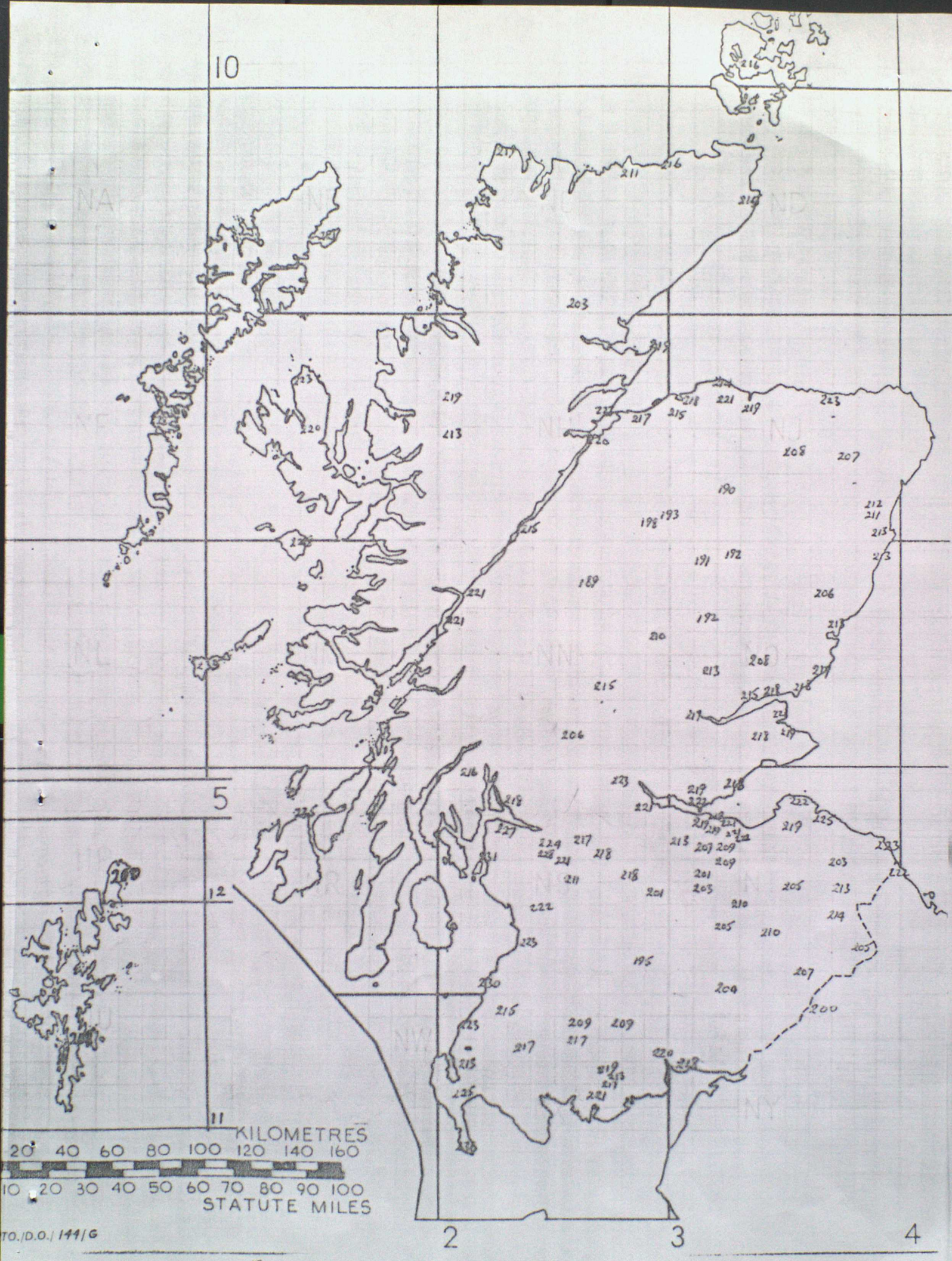
END OF GROWING SEASON (BASED ON MEAN AIR TEMP. ABOVE 6°C)

MAP 2



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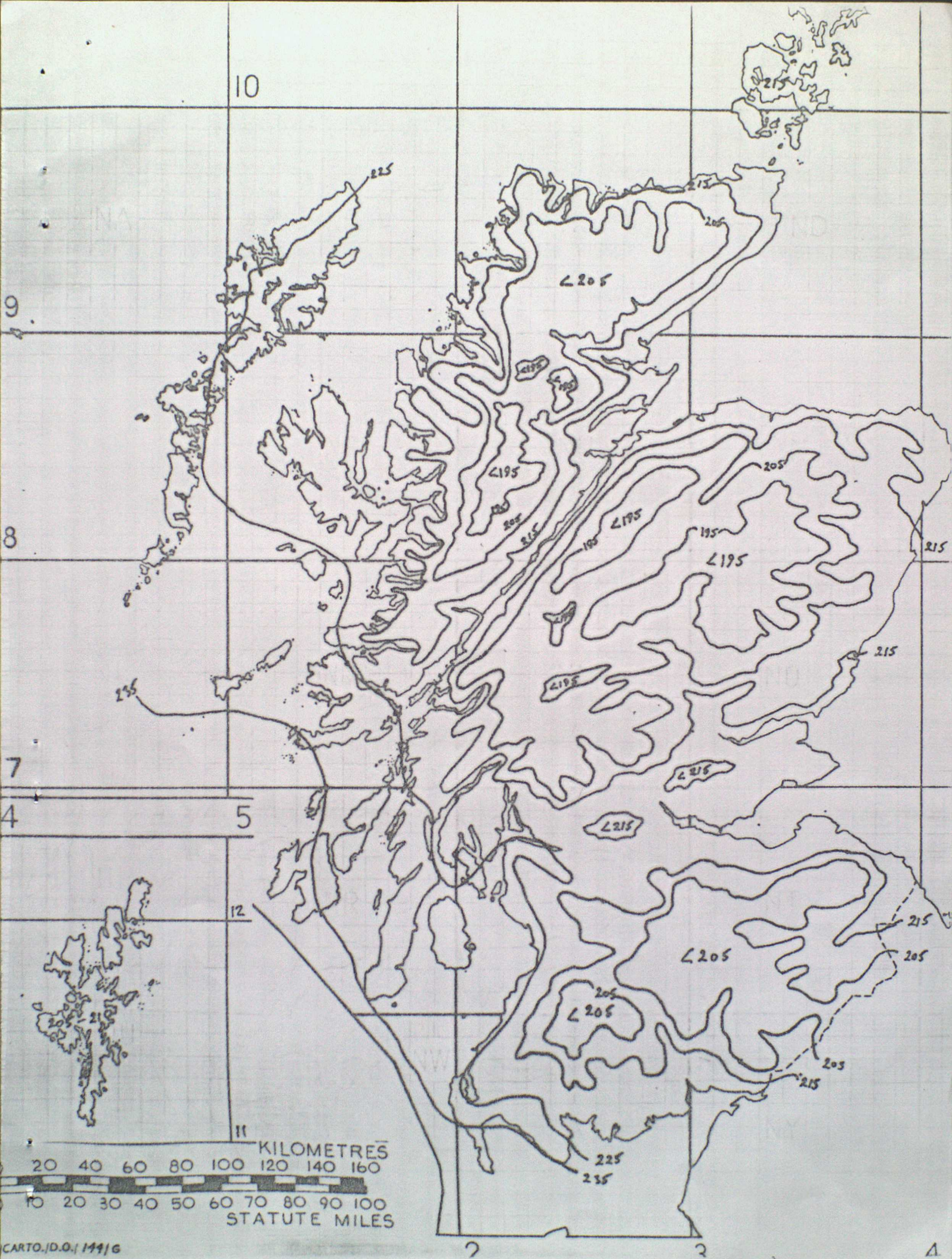
LENGTH OF GROWING SEASON (BASED ON MEAN AIR TEMP. ABOVE 6°C)

MAP 3



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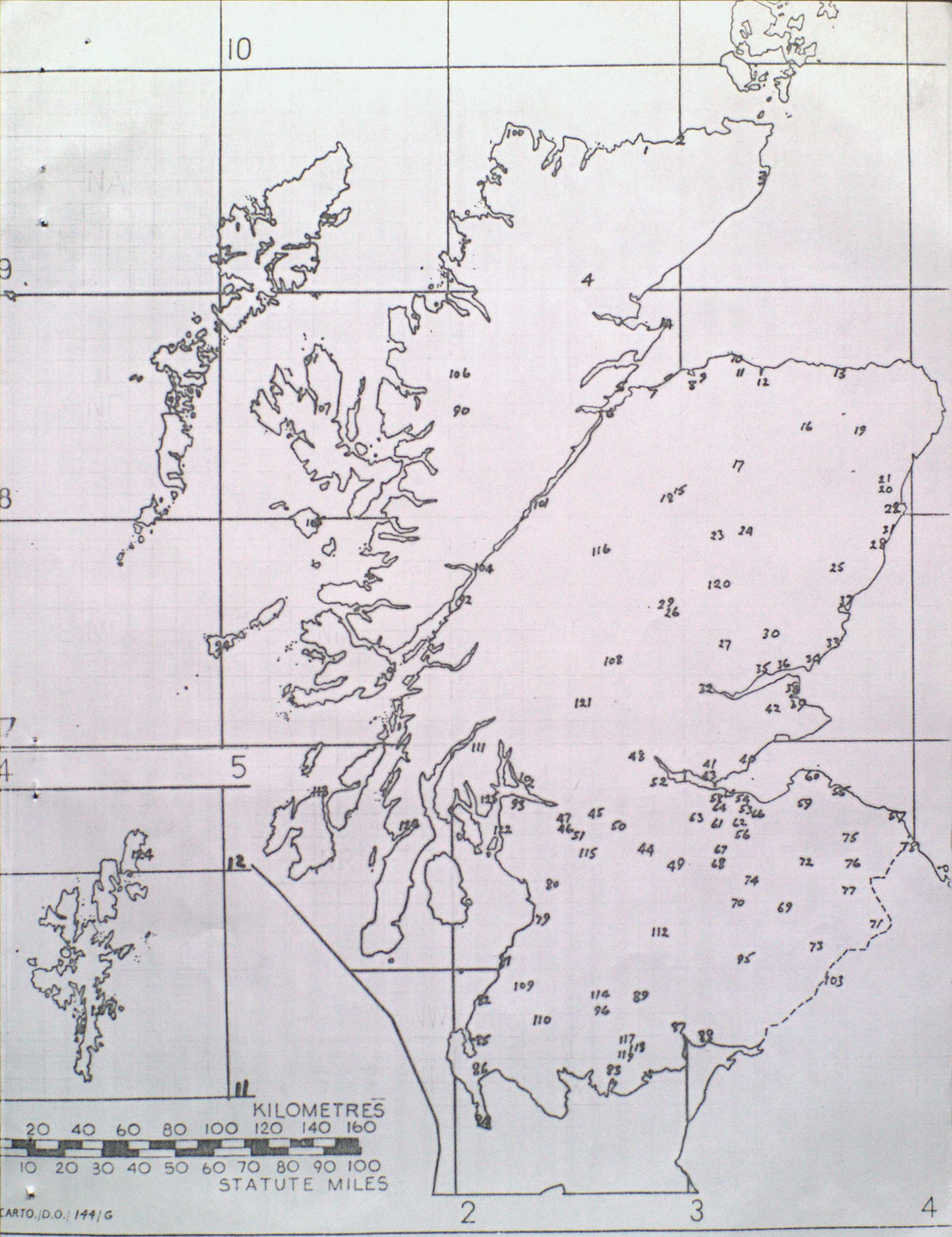
AVERAGE LENGTH OF GROWING SEASON (1941-1970) (BASED ON MEAN AIR TEMP ABOVE 6°C.)

MAP 4



KEY TO STATIONS LISTED IN TABLE II

AVERAGE LENGTH OF GROWING SEASON (1941–1970)

Based on mean air temperature above 6° C

- *Last week in April to last week in October*
- *Third week in April to end of October or beginning of November*
- *Second week in April to first or second week in November*
- *First or second week in April to second week in November*
- *First week in April to second or third week in November*
- *End of March to beginning of April to third week in November*

MAP PREPARED BY COUNTRYSIDE COMMISSION OF SCOTLAND.

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